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Technical Proposal No. 716

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on

A Test and Calibration System
For Passive Intercept Receiving Systems

Dated

25 November 1955

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I. Subject:

A Test and Calibration System for Passive Intercept Receiving Systems

II. Introduction:

This proposal is submitted in response to a request from the Department of Defense for the development of a test and calibration system to be used with the wide band passive intercept receiving system now under development. The general requirements for the subject test and calibration system were outlined and discussed at a conference on October 3, 1955 at the [redacted].

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Following the request from the Department of Defense for the subject system, a study of the needs and requirements was made by the [redacted]. It was learned that a similar problem had arisen with respect to [redacted] designed and manufactured by the [redacted]. In a conference with the [redacted] representatives the problem was discussed and a plan formulated for design and construction of a test and calibration system to be used with the wide band passive intercept receiving system which would employ techniques derived from the solution of the previous military equipment testing problem.

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Since the subject receiving system has a very much greater frequency range than the military equipment manufactured by the [redacted] a substantial amount of developmental work is necessary to integrate the test and calibration system with the receiving equipment now under development. However, a fair amount of groundwork for the design and construction of a wide frequency range test and calibration system has been achieved on the basis of aforementioned manufacturing of the similar military equipment. The groundwork having been formed, it requires an increase in scope, both in numerical complexity and in frequency range of the test and calibration system manufactured by the [redacted] to adapt the underlying principles to the subject test and calibration system.

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At the present time the [redacted] is under contract to the [redacted] for design and manufacture of antenna systems, including crystal detecting systems and auxiliary devices, for use with the subject wide band passive intercept receiving systems. The [redacted] has offered to increase the scope of their effort in designing, integrating and packaging the test and calibration system for the subject receiving equipment. It is felt imperative both by the [redacted] and the [redacted] that in any increase of scope

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to the present subject receiving system the design of and incorporation of band pass filter systems be made a part of the subject receiving system.

The importance of combining the band pass filter system with the test and calibration system cannot be overemphasized. It is realized that the test and calibration system can be designed to be used without filters, but the operational use will be severely limited.

It is proposed that the scope of the present developmental program of work be extended to allow for:

1. Incorporation of band pass filter systems into the present subject wide band passive intercept receiving systems.
2. Development and manufacture of test and calibration systems for use with the present subject wide band passive intercept receiving systems.

III. Statement of the Problem:

Essentially the wide band passive intercept receiving system under development consists of a means for intercepting a transmitted signal in the frequency range of 50 to 40,000 megacycles in any azimuthal direction with the objectives of presentation upon an indicating device and/or immediate analysis with an auxiliary oscilloscope and earphones and/or later analysis with the use of auxiliary storage devices. To obtain the desired effectiveness of the system a means must also be found for self-testing and self-calibration. A laboratory method of precision testing and calibration using signal sources which have been absolutely or relatively calibrated is impractical for the wide frequency range employed.

A simple and easy to use, yet accurate method of testing and calibrating is much more desirable. Since a multiplicity of detectors, amplifiers and other units are employed in the receiving system, a means for locating a defective unit would be advantageous. Finally, a calibration check prior to operational use would give assurance as to system accuracy and reliability.

IV. Technical Planning:

A. Band Pass Filters

It is the consensus of opinion that from a technical standpoint band pass filters should be employed on Bands 1 through 6. The following is the exact frequency ranges specified for these bands:

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Band 1	-	50 to 170 Mc
Band 2	-	170 to 400 Mc
Band 3	-	400 to 1000 Mc
Band 4	-	1 to 2.2 Kmc
Band 5	-	2.2 to 4.5 Kmc
Band 6	-	4.5 to 10 Kmc

Filters above 10 Kmc would not be supplied. Since the horns used above 10 Kmc have crystal detectors incorporated in the structure, the time required for developing filters within the horns would be excessive. It is estimated that the horn selectivity would be sufficient to attenuate unwanted signals in adjacent frequency ranges and that low frequency signals would be effectively attenuated by the horn throat acting as a high pass filter.

The employment of band pass filters for bands 1 through 6 would improve the operational advantage of the receiving system. Signals received on one band would be restricted to that band, avoiding ambiguity as to the determination of the frequency band of activity, which is the primary function of the equipment.

A case in point is that of a strong undesired signal in an adjacent frequency band masking a weaker desired signal in the band of interest, with no attenuation of the strong signal, due to lack of filtering, the weaker signal may be missed entirely.

The nature of the proposed filters for each band are as follows:

Band 1	-	Lumped constant elements
Band 2	-	Lumped constant elements
Band 3	-	Lumped constant and distributed elements
Band 4	-	Lumped constant and distributed elements
Band 5	-	Corrugated ridge waveguide
Band 6	-	Corrugated ridge waveguide

In the event the antenna design dictates a revised frequency division below 1000 megacycles, the filter ranges will be revised accordingly.

For each of the filters the design goals shall be:

1. Insertion loss within the pass band-less than 4 db.
2. Attenuation - greater than 40 db within 10% of the low and high frequency band limits.

If the design work, which mainly consists of accurately positioning the pass band limits of each filter, is done

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concurrently with the present antenna and crystal detector work the packaging problem can be integrated as a whole. In the event approval for the filter work is delayed, a modification of the existing antenna and crystal detector packaging will be necessary.

Primarily the filter system directly affects the parameters determining the design of the test and calibration system. Without filters the spectral energy of an impulse generating system is widely distributed. It is difficult to accurately specify the sensitivity of a receiver without restrictions upon pass band acceptance. Too much energy outside of the spectrum of interest will give an erroneous conception of receiver response. Controlling the spectral response of a receiver by means of filters will allow for a more reliable test and calibration system.

B. Test and Calibration System

It is proposed that impulse line generators be used for testing and calibrating the receiving system. This is suggested for the following reasons:

1. Simplicity, compared to laboratory generator methods.
2. Power supply requirements minimized.
3. Can be easily mounted within the antenna structure.
4. Eliminates long R.F. cables, thus keeping attenuation of test signals to a minimum.
5. Provides direct calibration without expensive attenuators.
6. Requires no tuning elements.
7. Small size and weight.
8. Low cost.
9. Maintenance problems minimized.

A complete system test can be made by turning on the test generator and the results checked just before the receiving system is expected to be used. All component units can be investigated and calibrated with the exception of the antennas. No plan for testing the antennas prior to use of the receiving system is contemplated herein.

A system employing impulse lines for a similar application has been successfully used up to 12 Kmc by

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[] Environmental tests made on the impulse units have a maximum of 1 db variation over the temperature range specified in the use of the receiving equipment.

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The fundamental theory of the type of impulse line generators which are manufactured at present is that of a coaxial line section with a movable center conductor. The center conductor makes contact at either end of the line depending upon which of the coils at each end of the line is energized at that particular instant. In one position the line is charged to a pre-set voltage and in the reverse position the line is discharged into an impedance equal to the characteristic impedance of the line. This produces a pulse that is rectangular in shape and a fraction of a milli-microsecond in duration. The amplitude versus frequency response of this pulse is practically flat to $\frac{0.1}{T}$ where T is the pulse duration. The power output level is proportional to the charging voltage. This gives rise to a simple, accurate and reproducible method of calibration.

This type of calibration is also used to accurately determine the broad-band calibration of Receivers used for Radio Interference Measurements.

An investigation of the available impulse lines indicates that the following can be used to advantage for complete coverage of the nine bands:

1. Bands 1 to 4 - Stoddart type 90857-1 or a mercury contact type also manufactured by the Stoddart Aircraft Radio Co., Inc.
2. Band 5 and 6 - Stoddart type 90857-1
3. Band 7 and 8 - Evaluation and development required with possibility of using lines produced by Empire Devices Products Corp.

The following table, prepared by [] [], shows the approximate output level at given frequencies, stated in microvolts per megacycle of bandwidth for the maximum rated charging voltage.

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<u>Frequency</u> <u>Kmc</u>	<u>Stoddart</u> <u>Hg Contacts</u>	<u>Stoddart</u> <u>90857-1</u>	<u>Empire</u> <u>Type A</u>	<u>Empire</u> <u>Type B</u>
1	100,000	10,000		
10		780		
20			1500	1000
40				1000

It should be noted that for the upper bands the output level, being proportional to bandwidth, is appreciable.

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The nature of the system would be as follows:

1. The impulse line generators would be located within the antenna structure.
2. Power for operation of the generators would be derived from the battery supply of the present receiving system.
3. The RF energy from the generators would be fed to a distribution box located in the antenna structure.
4. The distribution to the various bands would be controlled by a coaxial switch arrangement.
5. The RF energy would be inserted into the various bands by Probe Injection Units. These would not decrease the sensitivity of the receiver.
6. Synchronization would be obtained from a crystal detector system.
7. The observation monitor would be the Tektronix oscilloscope employed as auxiliary analyzing equipment for the receiving system.
8. The control circuits for the level of signal from the generators would be located at the console unit of the receiving system.

In the opinion of [REDACTED] an investigation of the available impulse lines would be made with regard to the available output level in each band and with due consideration of environmental and performance aspects, i.e. variations in output level with time, maintenance problems and general reliability. A study of the distribution of the energy to the various band insertion points will be conducted simultaneously.

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Finally, the packaging, integration and construction of test and calibration system including band pass filters will be undertaken in close cooperation with the work under way on the receiving system.

It is intended that a major portion of the construction and unit testing work will be performed by the [REDACTED].

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V Items To Be Delivered:

<u>Item</u>	<u>Quantity</u>	<u>Description</u>
1	3	Design and construction of Band - pass filter systems as described herein for Bands 1 through 6.
2	3 sets	Spare parts for Item 1
3	3	Design and construction of Test and Calibration systems as herein described to be used on Bands 1 through 8.
4	3 sets	Spare parts for Item 3

VI Delivery:

The design and construction of the additional items above will extend the delivery date of the first system to April 30; system #2 45 days following the delivery of the first system; and system #3 90 days following delivery of the first system. This assumes that approval is obtained on or about December 15.